EFFECT OF BALANCE TRAINING ON VARIOUS AGE GROUPS IN GAIT AND POSTURAL SWAY

BY

KIRAN KUMARI

SYNOPSIS

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SUPERVISOR

DR. AMAR KUMR

SUBMITTED BY

KIRAN KUMARI

Department of sports biomechanics

Certificate

I hereby declare that the short synopsis **"Effect of Balance Training on Various Age Groups in Gait and Postural Sway"** being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Physical education under the department of sports biomechanics of lakshmibai national institute of physical education Gwalior (2020-21).

It is a bonafide record of original work carried out under the supervision of Dr. Amar Kumar and has not been submitted in full or part to anyother university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and the proof has been submitted.

DR. VINITA BAJPAI MISHRA (KIRAN KUMARI)

(HOD of sports biomechanics)

(Chairman,DRC)

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ABSTRACT

Gait is a normal walking pattern. It requires strength, balance, sensation and coordination of muscles to propel the body forward in a rhythm, called the stride.Postural sway, in terms of human sense of balance, refers to horizontal movement around the center of gravity**.** This study aims to elucidate the effect of balance training on different age group in gait and postural sway material and method sixty female participant of Gwalior would be considered. Study has been conducted on girls only and they are divided in different age category i.e. (14-17) , (17-20), (20-23) and their separate control group. All three group performed balance training. All participants were treated two consecutive days every week and overall for eight week. Pre and post treatment data was collected for balance training. Results it would be hypothesize that all three groups would show significant within group difference and favor the treatment group compared to control group. Conclusion finding of the study would suggest there would be a significant effect of balance training on different age group and hope for greater improvement in postural sway and gait.

Keywords: balance training or postural sway, balance training and gait cycle, effect, girls, different age-groups.

Chapter -1
INTRODUCTION

Biomechanics is the most helpful in improving the performance in sports or activities where technique is the dominant factor rather than physical structure or physiological capacity (Duane Knudson, 2007). Since biomechanics is essentially the science of movement technique. Biomechanical tools are needed to analyze human motion, improve performance, demonstrates the fundamental movements, and reduce the risk of injury (Duane Knudson, 2007). The use of biomechanical tools will emphasize the qualitative and quantitative understanding of mechanical concepts.

In biomechanics, balance is an ability to maintain the line of gravity within the base of support with minimal postural sway. Sway is the horizontal movement of the center of gravity even when a person is standing still. A certain amount of sway is essential and inevitable due to small perturbations within the body (e.g., breathing, shifting body weight from one foot to the other or from forefoot to rear foot) or from external triggers (e.g., visual distortions, floor translations). An increase in sway is not necessarily an indicator of dysfunctional balance so much as it is an indicator of decreased sensorimotor control.

Gait is a normal walking pattern. It requires strength, balance, sensation and coordination of muscles to propel the body forward in a rhythm, called the stride. Gait cycle begins when heel strike of one foot follow the heel strike of the same foot in preparation for the next step. The gait cycles consists of a stance phase and a swing phase.Gait contribution to symmetrical index based on Normal walking speed. It involves the lower extremities, arms and trunk which provide stability and balance. Faster walking movements have more contribution on upper extremities and trunk propulsion with regards to balance and stability. In bipedal few of the major joints of the lower body and pelvis rotation work with each other as muscles and momentum of the body.

The degree to which the body's center of gravity moves during forward translation defines efficiency. Center of body's moves both side to side and up and down during gait.

Gait Cycle: Human walking is cyclic and comprises movement of different body parts. When gait characteristics viewed laterally (side view) exhibits cyclic nature. Therefore, a gait cycle is defined as the basic unit of gait comprising two strides and gait cycle refers to the time interval between initial foot-to-floor contacts for the same foot (Mark Nixon and John Carter).

Yoga is a group of physical, mental, and spiritual practices or disciplines which originated in ancient India.

Postural sway, in terms of human sense of balance, refers to horizontal movement around the center of gravity. This sway is essential due to the many large and small changes in the center of gravity due to functions such as walking and breathing. For a person to maintain balance requires coordination of input from multiple sensory systems including the vestibular, somatosensory, and visual systems. The vestibular sense controls equilibrium and directional information as it relates to head position and is related to middle ear. The somatosensory system senses information from skin and joints (pressure and vibratory senses) along with spatial position, movement relative to the support surface, and movement/position of different body parts relative to each other. The visual system works by reference to the verticality of body and head motion and spatial location relative to objects. These systems together coordinate to allow us to maintain balance: the more balanced the less postural sway.

Balancing asana on both leg and One-legged poses give us a chance to find our center of gravity and dance around its edges. Here's how to still the wobbling and create a sense of fluid stability. Concentrate on keeping your head, trunk, pelvis, and both of your legs balance. Strong internal sense will help your nervous system calibrate movements that maintain equilibrium around the line

While balancing on one leg like Vriksasana (Tree Pose) and ArdhaChandrasana (Half Moon Pose) demand our full, wakeful attention in a way that other standing poses do not. The instant we lose focus, we fall over. There is an unavoidable immediacy to these balancing asanas. Standing on one foot, we naturally drop extraneous thoughts to focus on the task at hand. That's

why these poses can instill a deep sense of calm even though they require intense, unwavering alertness.

When we balance, we align our body's center of gravity with the earth's gravitational field. Quite literally, we place ourselves in physical equilibrium with a fundamental force of nature. But we can't achieve this harmony by remaining absolutely still. Instead, we must refresh our balance moment after moment. The sustained effort to center and recenter, when successful, brings not only our flesh and bones into balance but also our nerve impulses, thoughts, emotions, and very consciousness. Hence, we feel calm. One-legged balancing asanas offer so many benefits that it's well worth the trouble to practice them. In addition to promoting concentration and calm, these poses strengthen our muscles and build our coordination and balance, improving our ways of standing and walking as well as how we perform many other everyday activities.

Balancing the body on one leg is much like balancing a seesaw. The same laws of physics apply: If you align the center of gravity over the base of support, you balance. If you don't, you don't. It's as simple as that. Of course, since your body is quite a bit more complicated than a seesaw, balance is often not so simple to achieve.

When you stand on one foot, one leg must do the work of two. (https://www.yogajournal.com/lifestyle/plumb-perfect). When lifting one leg while standing on the other leg, it can help to not only stabilize the pelvis, waist and ribcage, but also to change their shape as required so that the muscles operating on the leg have room to move (www sensational-yoga-poses.com/stability-in-yoga-poses.html).

BTS G-SENSOR 2 is a wireless system consisting of 4 inertial platforms each of them composed by a triaxial accelerometer, a magnetic sensor, and a triaxial gyroscope combined with the sensor fusion technology. The system, worn by the subject being analyzed, provides a series of parameters that, through elaborated algorithms, analyze various movements including w alking, running and j um ping.

The G-SENSOR 2, combined with the software G-STUDIO and a wide range of analysis protocols, constitutes the G-WALK®: an extremely intuitive and easy-to-use solution that provides accurate, objective and quantitative data. The speed of test execution, which doesn’t require any patient preparation, together with the automatic report generation, makes this system

an indispensable tool for a wide range of applications: prevention, diagnosis and follow-up of rehabilitation or pharmacological interventions.

Pedobarography is the study of pressure fields acting between the plantar surface of the foot and a supporting surface. Used most often for biomechanical analysis of gait and posture, pedobarography is employed in a wide range of applications including sports biomechanics and gait biometrics. Pedography, also known as plantar dynamic pressure distribution measurement, helps in clinical routine to gain important information for the diagnosis of the foot function that could not be obtain otherwise. The system allows for a more accurate definition of the treatment strategy in combination with other clinical and diagnostic examination methods.

Problematic foot conditions can occur unilaterally or bilaterally. Foot pain affects activities of daily living, such as shopping, walking, or heavy housework. Pain during walking is associated with high plantar pressures along the bottom of the foot, as well as the second metatarsal head. The average pressure generated beneath the second and third metatarsal heads is associated with higher plantar pressures overall. Considering this, higher planter pressure discomfort, in turn, causes gait and balance impairment.

If you work on your single leg balance every day, you'll find not only will you be able to stand with eyes closed, but also be able to begin to rotate left and right with your eyes closed. The goal is to reduce your dominance on vision and improve your use and perception of "feel." It works. While standing on one leg if you close the eyes then movement will be slow down. . Somatosensory information is very fast. There is a direct relay between the sensory and motor reflexes both inside and outside the brain – resulting in fast rapid "micro-corrections" of position.

Almost every standardized assessment for balance testing has an eyes-closed component to assess just what we mentioned above (the 3 things that impact proprioception). It allows the examiner to differentiate how well you use different skills that affect balance. If the eyes closed part is the issue, and this is connected to faulty foot and ankle mechanics during running, it give me more information as to what your limiters are as a runner.

There are a good number of studies available on gait and postural sway in biomechanical research but there is no studies available on effect of balance training on various age group in

gait and postural sway.While performing bilateral standing on firm surface in eyes open (EO) and eyes close (EC) conditions.

STATEMENT OF PROBLEM

The aim of present study is to see the effect of balance training on various age groups in gait and postural sway.

OBJECTIVES OF THE STUDY

1. To analyze the effect of balance training on gait parameter among various age groups from 14 to 17 years, 17 to 20 years and 20 to 23 years.
2. To analyze theeffect of balance training on postural sway among various age groups from 14 to 17 years, 17 to 20 years and 20 to 23 years in eyes open and eyes close.
3. To find out which age group has most significant improvement due to balance training?

DELIMITATIONS

1. The study will be delimited to the 60 male students of Gwalior.
2. The study will be further restricted to age range from 14 to 23 years (14 to 17 years, 17 to 20 years, 20 to 23 years).
3. The data will be recorded in two different condition with eyes open (EO) and eyes close (EC) on pressure plate for postural sway and on G-Sensor for Gait Analysis.
4. The selected parameter of gait will be as follows:
    a) Cadence
    b) Analysis duration
    c) Stance phase duration
    d) Swing phase duration
    e) Average speed
    f) Average pace
    g) Stride length
    h) Symmetry index
5. The selected parameter of postural sway will be as follow:
    1) Velocity parameters
        i. Center of Pressure

ii. Anterior Posterior
iii. Medial Lateral

2) COP displacement parameters
   i. Range of Anterior Posterior
   ii. Range of Medial Lateral

LIMITATIONS

Training, geographical conditions, etc. which may affect the results of the study which will be consider as limitation of the study.

HYPOTHESES

1. There will be significant effect in postural swayparameters in eyes open (EO) and eyes close (EC) among various age groups.
2. There will be significant effect in gait parameter among various age groups.
3. There will be significant effect due to balance training among various age groups in gait and in postural sway.

DEFINITION AND EXPLANATION OF TERMS

Biomechanics:

The science concerned with the internal and external forces acting on the human body and the effects produced by these forces. (Hay).

Gait:

Gait contribution to symmetrical index based on Normal walking speed. It involves the lower extremities, arms and trunk which provide stability and balance.

G-Sensor:

G-Sensor also known as an accelerometer, it is a sensor that can perceive the change of accelerating force.

Postural sway:

It is terms of human sense of balance, refers to horizontal movement around the center of gravity.

Pressure:

It is defined as force distributed over a given area.

Pressure Platform:

Pressure plate is the equipment used to measure the force running through the feet as walk/stand/run.

SIGNIFICANCE OF THE STUDY

- The result of the study will provide the knowledge about the gait on the basis of standard protocol for selected parameter, which will be helpful for coaches as well as students.
- The study will reveal the importance of the symmetry index, stride length, for the purpose of better efficiency and combination of right and left leg.
- The result of the study will provide the knowledge about the gait and postural sway which will help the students to avoid injury and improve stability.
- The result of the study will help the coaches to give better training with the help of biomechanical knowledge and analyze the students' performance critically.

Chapter-II

REVIEWS OF RELATED LITERATURE

The investigator has attempted in this chapter to locate the literature related to this study.The relevant literature found from various sources is cited below.

Blakemore (2003), reported that the brain is activated during physical activityby increasing blood flow to essential areas that may stimulate learning (Hillman. 2005). Therefore, research has suggested that integrating physical activity in the classroom will enhance student learning (Maeda et al. 2004). However, further studies are needed to make school authorities confident that encouraging school physical activity will improve learning rather than disrupt 'academic' time. Cognitive functioning is best defined as a). Intelligence (IQ), which is the ability to reason quickly and abstractly; b). Cognitive skills of concentration and attention; c). Academic achievement, usually assessed by overall school grades and performance.

Rene Fejer, Bruce Walker (2010) Studied on analysis of center of pressure (COP) excursions is used as an index of postural stability in standing. Conflicting data have been reported over the past 20 years regarding the reliability of COP measures and no standard procedure for COP measure used in the study design has been established. Six online databases (January 1982 to February 2009) were systematically searched followed by a manual search of retrieved papers. Thirty two papers met the inclusion criteria. The majority of the papers (26/32, 81.3%) demonstrated acceptable reliability. While COP means velocity, demonstrated variable but generally good reliability throughout the different studies (r=0.32 -0.94). No single measurement of COP appeared significantly more reliable than the others. Regarding data acquisition duration, a minimum of 90 sec is required to reach acceptable reliability for most COP parameters this review further suggests that while eyes closed readings may show slightly higher reliability coefficients, both eyes open and closed setups allow acceptable readings under the describe conditions (r_>0.75). Also averaging the results of three to five repetitions on firm

surface is necessary to obtained acceptable reliability. A sampling frequency of 100 Hz with a cut off frequency of 10 Hz is also recommended. No final conclusion regarding the feet position could be reached. The studied reviews show that bipedal static COP measures may be used as a reliable tool for investigating general postural stability and balance performance under specific-conditions. Recommendations for maximizing the reliability of COP data are provided.

Murray et al. '3 and Praetor et al.16: Observed quite correctly that the excursions of the COP were always greater than the COG and that the COP signal oscillated either side of the COG at a higher frequency. Thus in our review of postural studies we will correctly interpret that the COG excursions are smaller than the reported COP fluctuations in both the A/P and M/L directions. In all studies of normal subjects, when the subjects stood with their eyes closed6X1i, i7-i9 the COP amplitude was higher in both A/P and M/L directions. In single support not only were the COP amplitudes higher for eyes closed but also the fluctuations in the three ground reaction forces were significantly larger. Other measures of COP displacement were path length and area.

Cordo and Nashner46: Subjects pull a handle against a load. They recorded from the focal muscles (biceps) and from lower limb balance muscles (gastro- nemii + hamstrings). Based on latencies referenced to the activation of the focal muscles it was reported that the gastrocnemii and hamstrings were activated about 60 ms earlier. Thus the CNS stabilized the postural system in advance of the anticipated arm perturbation. Similar results for voluntary pushes and pulls by the arms47 were evident from the anticipatory COP changes recorded with force platform.

Jerrold Petrofsky et.al, (2014) eyes open vs. eyes closed, the sway increased. For example, when comparing the sway for the first two positions, standing feet apart eyes open vs. eyes closed, sway increased from Feet Apart Eyes Open to almost doubling in Feet Apart Eyes Closed. This increase was significant ($p<0.01$). Subjects were challenged even further when they stood on a foam pad. In the last 2 positions sway was increased further. For the least difficult 5 positions, there was no statistical difference between the no orthotic, off the shelf and custom orthotic groups ($p>0.05$). But for the most difficult 3 positions tested for balance sway was significantly less in the foot orthotic groups than the no orthotic group ($p<0.05$). For the 2 most

difficult positions, the custom orthotics group has less sway than the off the shelf orthotics group ($p<0.05$).

Mann et al. Reported force platform measures of the initiation of gait of 10 subjects. Their COP recordings demonstrated an initial posterior and lateral shift towards the swing limb, then a rapid shift towards the stance limb as the swing limb unloaded. The shear forces in the A/P and M/L direction were reported; however, they equated these forces with the moment of the COM; in fact they stated that the ‘center of pressure represents the projection of the center of mass.

Chapter- III

PROCEDURE

In this chapter the selection of subjects, selection of variables, criterion measures, collection of data, administration of test and statistical technique applied will be described.

SELECTION OF SUBJECTS

There are three experimental group in which each group has 15 sample in age group 14 to 17 years, 17 to 20 years, 20 to 23 years and one control group. Total sample of the present study will be 60 from Gwalior.

SELECTION OF VARIABLES

Gait and postural sway of different parameters will be selected for the purpose of study will be asfollows:

- ❖ The selected parameter of gait are as follow:

1. Cadence
2. Analysis duration
3. Stance phase duration
4. Swing phase duration
5. Average speed
6. Average pace
7. Stride length
8. Symmetry index

- ❖ The selected parameter of postural sway are as follow:

3) Velocity parameters
   - Velocity COP

- Velocity AP
- Velocity ML

4) COP displacement parameters
   - Range AP
   - Range ML

CRITERION MEASURES

For the purpose of present study, the different parameter of gait and postural sway of static foot planter pressure of each selected subject will be recorded with the help of BTS P-Walk(Baropodometric pressure) platform and gait parameters through G-Sensor.

COLLECTION OF DATA

For the collection of data 60 subjects will be selected from Gwalior.Subjects will be instructed to stand in upright position on the pressure platform with the bare foot and focus on a point to hold specific position. All 60 subjects will be performed in two different condition, one time with the eyes open (EO) and other time with eyes closed (EC) and focus on a point for 10 seconds and gait parameters data will be recorded for 10 meter walkingthrough G-Sensorin the sports biomechanics department of LNIPE, Gwalior.

TRAINING PROTOCOL

1st and 2nd week

Total duration- 45 minutes				
Days of training	**Monday, Thursday(14 to 17 years)** **Tuesday, Friday(17 to 20 years)** **Wednesday, Saturday(20 to 23 years)**			
Activities	**One leg standing asanas– Duration-20minutes.**	**Eyes close 10min.**	**Eyes open 10min**	**Swiss ball/ balance ball exercise (30 sec x 2)**
a	**Vrikshasana(30sec x 4)**	**30sec x 3**	**30sec x 3**	**One leg and both leg**

				balance exc.
b	Natrajasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
c	Dandyamanjanusirshasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
d	Veerbhadraasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.

3rd and 4th week

Age-group- 14 to 17, 17 to 20, 20 to 23				
Total duration- 50 minutes (5% reduce the recovery time)				
Days of training	Monday, Thursday(14 to 17 years) Tuesday, Friday(17 to 20 years) Wednesday, Saturday(20 to 23 years)			
Activities 1)	One leg standing asanas– Duration-20minutes.	Eyes close 10min.	Eyes open 10min	Swiss ball/ balance ball exercise (30 sec x 2)
a	Vrikshasana(30sec x 4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
b	Natrajasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
c	Dandyamanjanusirshasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
d	Veerbhadraasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.

5th and 6th six week

Age-group- 14 to 17, 17 to 20, 20 to 23	
Total duration- 55 minutes(10% reduce the recovery time)	
Days of training	Monday, Thursday(14 to 17 years) Tuesday, Friday(17 to 20 years) Wednesday, Saturday(20 to 23 years)

Activities 1)	One leg standing asanas– Duration-20minutes.	Eyes close 10min.	Eyes open 10min	Swiss ball/ balance ball exercise (30 sec x 2)
a	Vrikshasana(30sec x 4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
b	Natrajasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
c	Dandyamanajanusirshasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
d	Veerbhadraasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.

7th and 8th eight week

Age-group- 14 to 17, 17 to 20, 20 to 23				
Total duration- 60 minutes(15% reduce the recovery time)				
Days of training	Monday, Thursday(14 to 17 years) Tuesday, Friday(17 to 20 years) Wednesday, Saturday(20 to 23 years)			
Activities 1)	One leg standing asanas– Duration-20minutes.	Eyes close 10min.	Eyes open 10min	Swiss ball/ balance ball exercise (30 sec x 2)
a	Vrikshasana(30sec x 4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
b	Natrajasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
c	Dandyamanajanusirshasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.
d	Veerbhadraasana (30sec x4)	30sec x 3	30sec x 3	One leg and both leg balance exc.

ADMINISTRATION OF TEST

Each selected subjects will we instructed to attend the regular training program up to eight-week. Pre and post data will be recorded on gait parameters with the help of G-sensor and postural sway parameter on pressure plate. Procedure of data collection for each activities during pre- test and post test will be demonstrated and explained to the subjects.On the basis of explained procedure, pre and post data will be recorded for selected sample.

RELIABILITY OF THE DATA

To acquire valid measurement, the tool which will be used for the purpose of the present study is Baropodometric pressure platform and G-sensor available at the research laboratory of Lakshmibai National Institute of Physical Education, Gwalior, and the reliability was established by the manufacturers. All measurements will be recorded with the help of research scholar under the supervision of experts. So, the data collection for the present study will be considered reliable.

Statistical Procedure

1. To see the effect of balance training ANCOVA will be used as a statistical tool at 0.05 level of significance.

EXPECTEDOUTCOME

- The result of the study will provide the knowledge about the gait on the basis of standard protocol for selected parameter, which will be helpful for coaches as well as students.
- The study will reveal the importance of the symmetry index, stride length, for the purpose of better efficiency and combination of right and left leg.
- The result of the study will provide the knowledge about the gait and postural sway which will help the students to avoid injury and improve stability.
- The result of the study will help the coaches to give better training with the help of biomechanical knowledge and analyze the students' performance critically.

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